PEWG

HCAT Hard Chrome Alternatives Team

A DoD/Industry collaboration to replace hard chrome plating with HVOF thermal spray

Engineered Applications of Electro-Spark Deposition (ESD) for Component Repair

AC9163-5

Mike Dent - PEWG
Program Manager

Clayton Lindsay - ASAP
Mechanical Engineer

HCAT TWG Meeting
Toronto, Ontario
September 24th, 2002

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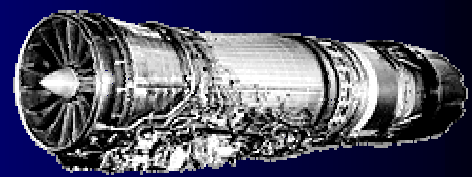

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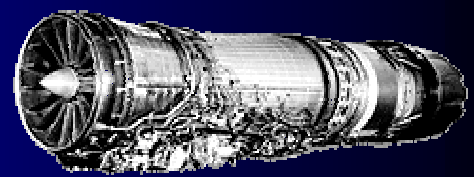
Project Objective

- To determine feasibility of utilizing the ESD process for cost effective repair of components
  - No known method of repair
  - Existing repairs utilize HAZMATS
    - Repair of HAZMAT coatings
  - Current repairs impractical
  - No replacement parts available



Participants

- PEWG
- ESTCP/HCAT
- GEAE
- PW
- Oklahoma City ALC
- NADEP Jacksonville
- NADEP Cherry Point
- NADEP North Island
- Anniston Army Depot
- Corpus Christi Army Depot
- ARL
- AFRL
- NRL
- PNNL
- EWI
- NSWC Carderock
- US Army IEC
- Boeing St. Louis
- Rowan Technology Group
- Dynamics Research Corp.

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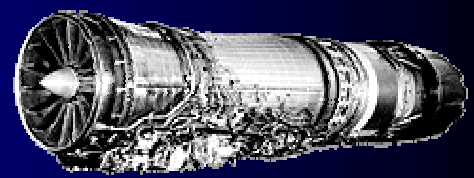
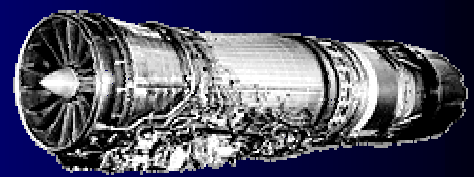


Project Scope

- ESD repair of Electrolytic Hard Chrome (EHC) coatings
- ESD repair of component substrate materials



Project Methodology - GTE

- Select candidate materials and electrodes
- Optimize ESD parameters for selected substrate/electrode combinations
- Perform materials evaluation and mechanical testing
- Create candidate part screening criteria based on test results
- Develop repair procedures for candidate parts
- Test candidate parts as required
- Implement technology

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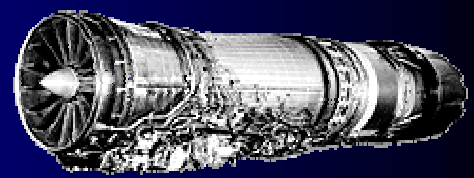
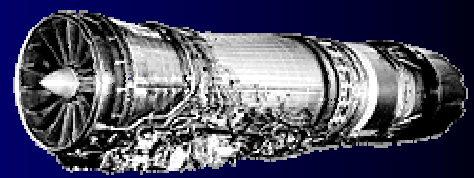


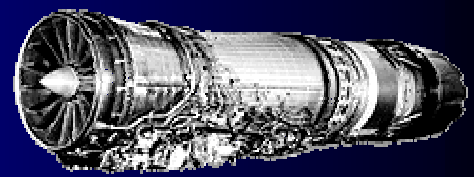
Repair of EHC - Status

- Work Completed
  - Materials Identified
  - Some materials obtained
  - Some specification identified
  - Some candidate parts identified
  - Most information based upon HVOF JTP



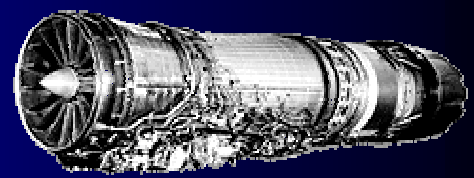
Repair of EHC - Materials

- Base Materials
  - IN718, AMS 5663
  - 4340, AMS 6415
  - 17-4PH, AMS 5355
- Possible Electrodes
  - Chromium
  - Ni-Chrome
  - Carbides
- EHC
  - MIL-STD-1501
    - Supported by QQ-C-320
  - .003” - .015” thickness



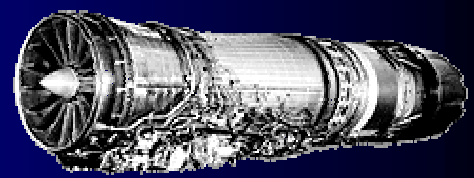
Substrate Repair - Status

- Candidate materials selected
- Most material received
- Gathering materials and mechanical testing information
- Beginning process optimization
- Drafting process specifications based upon optimization results



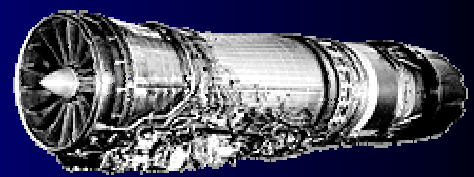
Substrate Repair - Materials

Substrate	Specification	Electrode Specification
IN 718	AMS 5663	AMS 5832
IN 625	AMS 5666	AMS 5837
Hastelloy X	AMS 5754	AMS 5798
Haynes 188	AMS 5772	AMS 5801
410 Stainless	AMS 5504	AMS 5823
17-4PH	AMS 5604	AMS 5825



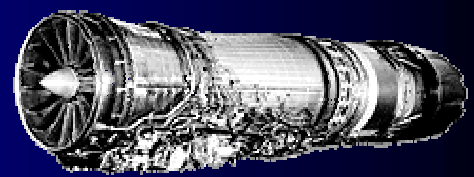
Substrate Repair - Optimization

- Using DOE approach to optimize ESD parameters
  - Varying Capacitance, Voltage and Current
  - Measuring Deposition Rate, Inclusion %, Bond and HAZ
- Repairs currently underway
  - 50% complete on Hastelloy X
  - 40% complete on IN625



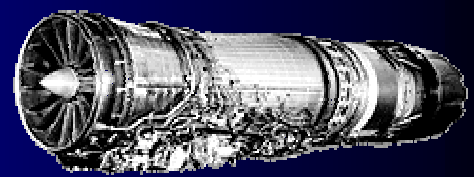
Materials and Mechanical Testing

- Materials Testing
  - Completed prior to mechanical testing
    - Iterative process to assist in ESD optimization
    - Metallurgical evaluations
      - Cracking, Porosity, Inclusions, etc.
    - Bond evaluations
      - Bond buttons, bend testing
    - HAZ
      - Micro-hardness gradients
    - Others ?? (residual stress, element mapping)



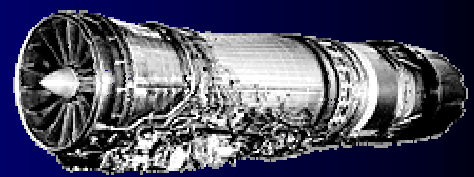
Materials and Mechanical Testing

- Mechanical Testing
  - Completed after ESD optimization, materials testing
    - Possible testing includes
      - Low Cycle Fatigue, High Cycle Fatigue (RT & Elevated) Tensile, Fatigue Crack Growth, Creep/Stress Rupture, Long Term Stability
    - DOE/Specifics needed
    - Definition of defect needed for each instance



ESD Specification & ESD Procedure

- ESD Specification - Based upon AWS D17
  - Definition of weld type (repair vs. coatings)
  - Qualification of welder
  - Acceptance Criteria
    - Initially based upon AWS D17, Class A, B & C ?
    - ESD specific criteria created during development ?
- ESD Procedure – Based upon AWS B2.1 ?
  - ESD equipment parameters
  - Technique description
  - Substrate/electrode/geometry specific



Questions -